A VIRTUAL ENVIRONMENT FOR URBAN COMBAT TRAINING

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ABSTRACT

Urban terrain is among the most complex of military environments and urban combat skills remain one of the most difficult to train. The Office of Naval Research VIRTE (Virtual Technologies and Environments) program is conducting research to enable Military Operations in Urban Terrain (MOUT) training for deployed Marines. This report briefly describes the initial development of a virtual environment (VE) specifically tailored to the needs of such training, particularly fighting in confined environments such as buildings.

1. INTRODUCTION

Key to the issue of representing urban combat environments is ensuring that these environments, in fact, lead to successful transfer of training for combat teams. In order to support the wide range of behaviors necessary for effective training, interactive technologies including multi-modal 3D displays and input devices, real-time rendering, and distributed simulation (i.e., multiple user interaction through networked VE systems) must be identified and their utility, from a performance enhancing perspective, evaluated. Specifically, in designing a VE for MOUT teams, a number of environmental cues essential for these teams must be considered to ensure that the resulting scenario allows practice of critical skills. To support this, features of the VE developed by VIRTE for MOUT includes realistic physics of movable objects (doors, grenades, and debris), realistic natural and artificial lighting, 3-D spatialized sound, and stereo vision. This environment is designed to support a trainee using a range of interfaces, including VE goggles and a 3-D body motion tracking system.

The representation of the synthetic natural (and man made) environment has been an on-going challenge for military modeling and simulation. While many aspects of this problem have been solved for vehicle-level simulators, individual humans perceive and interact with their environment in a much more complex way. Added to this complexity is the fact that teamwork is an inherent requirement of urban combat training. This requires a detailed, dynamic, interactive synthetic environment to be maintained among a distributed group of participants. Furthermore, the environment is not isolated to a few buildings, but must mesh directly with the larger battlefield. This requires a means to correlate with large scale terrain databases and interoperate with conventional vehicle simulators. All of these technology components must come together in a virtual training system that effectively supports training transfer.

1.1 Transfer of Training

One of the primary reasons that VE systems do not, as yet, provide a demonstrable training edge is likely that they fail to fully integrate the wide range of sensory cues typically associated with complex tasks (Cohn, 2003; Durlach & Mavor, 1993). The quality of the experience provided by VE systems is thought to directly relate to the degree to which the range of human sensory modalities is stimulated (Greenwald, 2002). Current systems focus primarily on supporting the visual modality, while stimulating other modalities in, at best, a rudimentary fashion.

Spatialized sound. While many current simulations primarily support the visual channel for the MOUT domain, auditory cues play a pivotal role in providing trainees with the ability to locate other objects in their surrounding environment (allocentric localization), as well as the ability to locate themselves within their surrounding environment (egocentric localization). In general, spatialized audio cues can be used to communicate direction, location, and movement, as well as in identifying auditory messages in noisy environments or guiding navigation tasks (Mulgund et al., 2002).

Haptics. The ability to fully exploit VE systems for training individuals or teams moving through an immersive VE is limited by the ability to render haptic

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(i.e., tactile and kinesthetic) stimuli. Haptic cues can play a critical role in supporting fully immersive VE training systems. They can be used to render any number of a wide range of sensations (e.g. force, vibration, texture etc).

Both spatialized sound and haptics provide multisensory cues that can be used to support the egocentric, interactive and affective characteristics present in VEs. When absent, the lack of multiple-modality information is suggested to adversely affect the degree to which VE training enhances real world performance (Paivio, 1991). Thus, there is great training potential for developing a method for providing multimodal information during immersive VE training.

A first step to ensure that training environments will lead to transfer of training is to ensure that the characteristics of a VE support the training objectives of a targeted task. In order to realize this objective, it is essential to address the sensorial shortcomings, such as those discussed above, of current VE training solutions. Secondly, to ensure training solutions are effective, the degree that transfer performance is achieved must be measured.

Typical approaches to evaluating the efficacy and transferability of training in VE lack consistency and validity. Further, these approaches often are limited in scope, focusing on individual performance, rather than on complex team performance, such as that associated with MOUT operations. Given the increasing reliance on VE training systems in military environments, there is a need to identify methodologies for objective measurement and assessment of individual and team performance to ensure that training systems are effective at facilitating development and maintenance of targeted training objectives and lead to transfer of training back to the operational environment.

When commencing the design of any training system, it is essential to examine real world teams in the targeted operational environment to determine which behaviors are important to train, and consequently, target for performance assessment. In the current effort, from MOUT observation and instructor interviews it was established that reducing the threat to the team and team communications were the most critical behaviors to ensure mission success. Given these global behaviors, a task analysis was conducted to investigate the specific individual and team behaviors that MOUT teams engaged in to ensure that these goals would be met in the training system. These sub-behaviors included traditional team performance behaviors (e.g. information exchange), kinematic team performance behaviors (e.g. maintaining formation between team members), and procedural behaviors (e.g. performing a series of tasks when entering a room), as well as those that facilitated overall performance. From this analysis, a list of potential metrics was generated as those that would be indices of successful MOUT mission performance.

The VE was then designed to allow practice and measurement of these metrics, through scenario design and automatic data collection. Thus, utilizing data and theory driven metrics, data collection was directed and targeted.

1.2 Transfer Approach

As a first step, iterations of the VE for MOUT will be examined as technologies (e.g. spatialized sounds, haptics) are integrated into the system. A series of experiments will then be conducted to validate the metrics derived from this effort, in addition to examining the unique and combined impact of VE technologies on transfer of training.

CONCLUSIONS

Given the emphasis on systematically incorporating multisensory components into VE system design that support transfer of training, incorporation of validated traditional metrics, and development of kinematic models of team and individual performance, this effort is uniquely positioned to maximize team training transfer. Further, with a strong theoretical foundation from which to design and evaluate multisensory VE systems, this effort can begin to address how to support and measure transfer of training for MOUT teams.

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